Geological Survey of Pennsylvania.

To His Excellency, Gen. J. F. Hartranft,
Governor of the State of Pennsylvania.

Philadelphia, Febrary 1, 1873.

Sir:—You have done me the honor to say that, if I have any information likely to be useful in proposing a geological survey of Pennsylvania, you will be pleased to receive and consider it.

I reply, that all well educated persons now recognize the importance of increasing human knowledge, believing not only that there is no limit to be put to this increase, but that every kind and quality of knowledge is, or will be, in some way or other, useful. Uneducated people find it hard to assign value to what looks to them abstract and unpractical, but business men who have had most experience and the best success in life, comprehend pretty well that the collection of natural facts and the discovery of natural laws are the foundations of civilization and the causes of American prosperity.

To collect facts and to arrange them for discovering laws of nature is an expensive and painful occupation. It is the business of men trained for that purpose; apart from the common transactions of mercantile and manufacturing society; unremunerative, and demanding the patient industry of the whole man, throughout his whole life. And many such trained minds must work together to accomplish results useful to the Commonwealth. This is true for every kind of scientific work. It is especially true of geology.

It is not generally known how entirely the buying and selling of mineral lands depends upon the private surveys and reports of professional geologists of established reputation for knowledge and truthfulness. Mining enterprises of respectable size are never undertaken now without first obtaining from some competent geologist a careful statement of his observations and advice; precisely as no railway is now built except upon the well considered report of an experienced Civil Engineer.

But these advantages are monopolized by the few who are able to pay for such surveys. A State geological survey is therefore essentially democratic in its nature, having for its object to prevent monopoly, and to publish such knowledge to all the citizens of the Commonwealth without regard to fortune. Knowledge which is bought at such high prices by wealthy landholders and incorporated companies *must* be desirable for all the farmers of the State; for the householders and trades-people of all its towns and villages; for every manufacturer and artisan however modest may be the part he plays in the business community. A survey costing annually $50,000, or $100,000 per annum, furnishes to the population of Pennsylvania, at the rate of five or ten cents per voter, information for which energetic speculators, large land-owners, and wealthy manufacturers are constantly paying from $500 to $2,000 apiece. And having paid such high prices for it they naturally keep it to themselves. Whereas the interests of the Commonwealth demand that it should be published to all citizens.

But a still stronger argument for a State Geological Survey comes from considering that geological knowledge requires the widest range of facts to make it reliable. There were many observers of the weather and good local weather prophets before the establishment of the Weather Service Bureau at Washington, two years ago. But no real knowledge of the weather was ever got by these private observers, sufficient to predict the great waves of cold and heat and wind. It required a government survey to accomplish this.

Just so, the local geology of this or the other man's property would be pretty much all costly guess work, but for the State Geological Surveys of 1836–1841, and 1852–3. That great work sketched out the general geology, studied

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details of the most important districts, put the parts and fragments together, established rules, and probabilities, recorded average measurements, and trained the professional geologists who, ever since then, have been surveying properties for mining, smelting, and railway interests. The first mineral State of the Union would be in a pretty situation to-day but for that State Geological Survey; much such a situation as a great warehouse without ledgers and clerks.

Twenty years have passed since the Geological Survey of the State ordered by the Legislature was ended. It is surely high time to recommence.

The first survey was in most parts of the State very imperfect. Parts were carefully surveyed and well described; but whole sections, now among the most important, were merely sketched out. These require accurate surveying and description. In a word, the first survey was in the very nature of the case, and at that early day, merely preliminary to a better and future one. This better survey ought now to be undertaken.

I will insist no longer on the need of a Survey but proceed to consider its character.

The points of most moment are as follows:—

I. Good maps are the basis of all useful research in every department of science and the arts, and especially in the political science of statistics, and in the practical sciences of geology and metallurgy. The geologist's work must be inaccurate and costly to his employers and to the community wherever no good map has been made of the ground. The first step of our geological survey ought to be the construction of a perfect map of the State; or at least of those parts of it which are to be first studied geologically.

We have sufficiently good maps of a number of counties. But the counties of the northern, middle, western and southwestern counties have no maps which are of the proper value to a survey. These should be mapped with road odometer surveys, as fast as practicable, taking them up in the order of their geological importance. Meanwhile

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the United States Coast Survey will obtain for us the absolute determination of one fixed point in the centre of each county; and triangulate for us, or at all events, greatly assist us in triangulating parts of the State on a sufficiently large, rapid and cheap scale to enable us to rectify and connect the county maps into a whole.

I have the assurance of Prof. Pierce, Chief of the Coast Survey, of the great interest he takes in our State Survey; and he is now connecting the shore lines of the Coast Survey across the continent; which connection will take place partly through Pennsylvania.

I deem it inexpedient to call for a new State Map at first. That will grow out of our County Surveys, and must wait for the astronomical and telegraph-time work; whereas the county odometer surveys can go on at once and rapidly. Two men (*i. e.*, a surveyor and his rod man) can survey a county in a year at an expense of about $3,000, or $2,500. We have very good practical county surveyors about the State; and if we had the money we might have a County Map of every county in the State by this day two years hence. But a surveyor should know something about geology; and the training which our county surveyors and their boys will get by this connection of road running with geological surveying ought to be one of the strong arguments in its favor. A geological survey when continued from year to year becomes a great and powerful school for several kinds of people, increasing their public usefulness in their professions and employments.

I should advise the mapping of five or ten counties per annum. When Robert Smith, the map publisher, had expended $80,000 in mapping most of the counties of New York, he applied to the Legislature of that State for aid to map the remaining wild counties where he could get no subscribers, in order to collate and publish a State Map. This was done by an act requiring every school district to purchase a copy or copies of the State Map and, I believe, of the county maps also. The cost of the work was more than covered, and at the same time the full publication and useful distribution of the State Map was secured.

The single counties ought to be published on a small scale as fast as made; and geologically colored as fast as studied. One uniform scale and size of page should be adopted, so that a handy atlas would be the final result. Cheapness and accuracy rather than artistic finish ought to be aimed at; the latter can be attained after the general wants of the public are satisfied. With our present art of printing and photographing, every man and child ought to have a colored geological and geographical (topographical) map of his own county (with a small scale map of the whole State) put into his hands for a few dimes; and that of the highest scientific correctness and completeness.

The model for a publication of this sort is a handy and handsome octavo Atlas of the Geology of England, in 33 colored plates, including a plate of England, and one of Scotland, the rest being plates of one county, or two adjoining counties, with every town and hamlet, small stream, road, railroad and park exhibited with perfect distinctness; the geological formations being colored over all. It seems impossible to improve on this book. It is sold very cheaply and is in the hands of a great many tourists and commercial travellers. It is prefaced with 16 pages only of geological explanations, including "Agricultural Geology and Water Supply." The maps of the Geological Survey of England formed the basis of this beautiful little atlas of Reynolds. And without the government surveys this useful popular manual would have remained an impossibility.

I consider the large and unwieldy county and local maps published by some of the State Geological Surveys of the United States mistakes. Everything needful can be shown on a smaller scale, with equal accuracy, and far greater convenience to the reader, tourist, and student in the field; with large saving of expense to the State.

The main point to be insisted on is the desirableness of laying the results before the public in a useful and accurate but cheap form; and as fast as the work advances, without waiting for the difficult and tedious compilation of an entire State Map.

Absolute perfection in science is unattainable. However accurately work may be done, still greater accuracy will be possible; however complete a long and patient study of a region or locality may make our knowledge, longer and more accurate study will always still further improve our knowledge. The very name of *Final* Geological Report should be abandoned. It is an absurdity. It has seduced ambitious men into a policy of postponing the publication of their researches long after a mass of most useful information for the public has been collected; for fear that errors have been committed, important details been overlooked, and their personal reputation may thereby be endangered. The right policy of a State Geologist, or of a State Geological Corps of Geologists, is to hand over to the public all reliable information as fast as obtained; as fast as consistent with conscientious carefulness.

I would urge, therefore, the prosecution of our State Survey by districts; and the publication of its maps by counties; in a cheap but handy uniform shape; to make an atlas which should grow in size from year to year. Of course the most important and the least understood districts should be surveyed and published first.

II. While a Geological and Metallurgical Survey of the whole State has been demanded by the general voice of the business community, and for the land ownership of all parts of the Commonwealth, it is especially wanted in the oil regions of the northwest counties, in the new bituminous coal basins of the western part of the State, and at the iron smelting and rail purchasing centres.

There are whole districts of the State's surface which remain as yet to a large extent unstudied by competent geologists pursuing the best method of research. There are problems of structure and deposit involving millions of dollars of value still unsolved, which nothing but well devised instrumental field-work can solve.

The old survey did a great work. It clearly portrayed the main features of the State. It told us exactly where to look for what we want to find. It has given us a very magnificent sketch, which we may now fill up. The new survey will not cost half as much, in time and money, as it would have cost had no previous survey been made. But when the survey was made in 1836-1841 there were no county maps; no State map but Melish's, which was full of errors in the best settled counties, and good for nothing in the back counties; and almost no good exposures of our mineral veins except in the anthracite coal basins and around Pittsburg. Now, the soil is everywhere full of trial shafts and trial explorations; the forests have been extensively cleared ; roads penetrate what were then inaccessible districts; railroad main lines and branch lines have covered whole counties with instrumental field-work; twenty thousand oil and salt wells have been bored; hundreds of mining properties have been put into working order; the population of the State has grown intelligent, observant, and enterprising ; and the scientific and practical skill of geologists, metallurgists and surveyors has reached a high pitch. We are now able and ready to grapple with the many difficult questions of number, order and quality of our coal beds ; where they run, how they lie, how they can best be mined, and how best connected with market. We are prepared to get full and accurate information about the oil, to show on maps the extent of the oil regions, and the depths to which borings must be sunk. We are, above all, ready and able now to take up the iron problem of the State, and find out the law of the deposits of the brown hematite ores.

III. I have stated the wants of the present generation. The next has also claims upon us. A most important function of a geological survey is to *preserve* knowledge *for future use.* Science is cumulative. It makes slow and painful advances. It is obliged to collect an abundance of facts before it comes to true conclusions. Pennsylvania has lost enormously during the last twenty years by having no bureau of statistics, no corps of observation and publication, to observe and preserve, collate and relate the facts of its geology and mineralogy as they have made successively their appearance. No Commonwealth can afford to be without such an apparatus for preserving from loss and forgetfulness the discoveries and investigations of private persons, even for one single year of its existence. Thousands of most valuable facts have been lost to us during an interval which cannot be recovered. How many openings on coal veins are now covered up, no one being able to give any reliable information about them! Twenty thousand oil borings have been made, and not one hundred of them are on record, if discoverable. Hundreds of gangways have been driven and abandoned, and cannot now be studied; many of which would disclose the nature of faults and disturbances which affect neighboring properties, and overlying and underlying beds not yet worked, where certain knowledge is preserved to govern the future mining engineer in his plans for getting at the mineral. He must work as completely in the dark as if this knowledge had never been got, and often paid for at a ruinous expense. The sooner a geological survey is established the better for the *future* interests of the State as well as for its present necessities.

IV. Geology and Mineralogy must carry on work in several different departments at the same time. A mapping office, a chemical laboratory, and a museum of minerals and fossils are necessary to good field-work. The field-work must be done by three kinds of experts working in harmony and mutually assisting each other: surveyors, geologists and palæontologists, or fossil shell and plant students.

A complete working corps, therefore, should consist of:—

1. A chief or director who is familiar with both topography and geology.

2. A chemist who must be also a good practical mineralogist and metallurgist.

3. A palæontologist who knows vegetable as well as animal fossils.

4. Assistants in the field to head surveying parties.
5. Assistants in the laboratory and museum.

But a survey of a great State like Pennsylvania cannot be carried on well without a still greater division of labor. For the sciences are now so extensive and difficult that their greatest experts are obliged to limit themselves to one department of one science. I should propose therefore if my advice were asked, some such organization as the following:—

1. A Director of the Survey, who shall take charge of the maps and field-workers, the illustrations and publications of the Survey.
2. A Chemist with his laboratory.
3. A Palœontologist in charge of the museum.
4. A Fossil Botanist to study the coal beds in all parts of the State, in the field.
5. An Assistant Geologist in charge of the Oil Regions.
6. An Assistant Geologist in charge of the topography and structure of the Bituminous Coal Region.
7. An Assistant Geologist in charge of the Iron Ore Regions of Middle Pennsylvania.
8. An Assistant Geologist in charge of the revision of the Anthracite Coal Region.
9. An Assistant Geologist in charge of the Primary (gold and chrome-bearing) rocks of the Southeastern district of the State, and one acquainted with the extension of this important belt of rocks through the Southern Atlantic States.
10. Men employed under the above, to handle instruments when necessary, make collections, draft maps, copy original documents, &c., &c.

It is no economy to employ inferior talent. Mistakes committed by inexperienced and incompetent persons produce not only present waste, but permanent mischief. Men of the best standing in the science would be eager and proud to take part in so great a work.

Young men trained in American and European Mining schools, are waiting to be employed as assistants. We are assured of a large amount of valuable *voluntary* assistance from the members of the Academy of Natural Sciences and from persons in various parts of the State. The Collegiate institutions at Easton, Bethlehem, Lancaster, Pittsburgh and other towns would be zealous to cooperate.

V. But men with families to care for must receive an adequate support. Commonly, the lives of such individuals have been spent in the unremunerative acquisition of knowledge, skill, experience and materials, which is only now bearing its natural fruit, enabling them to provide against the inabilities of age. The State should pay well for the best talent, where so much mischief might be done by incompetent persons. A State Geological Survey should not be made a mere stepping-stone to something better, or an advertisement for lucrative private professional work. There ought to be nothing better.

All traveling and carrying expenses ought to be borne by the Survey, and not to come out of the salary of the geologists and assistants. Such expenses can be reduced to a minimum by a candid application to railway companies, who will grant free tickets to the working corps of the Survey; and free transport for their collections. Great hospitality has always been shown to geologists on a public survey by all classes of people. There will still remain expenses which cannot be avoided; but a considerable portion of these fall on the first year of a survey; for instance, the purchase of field instruments and wagons, which are absolutely necessary for a proper and rapid exploration of any district of the State, whether cultivated or wild.

If you desire to know what idea of the cost of a State Survey my experience of such work for nearly thirty-five years enables me to form, I reply, that the cost will be commensurate with, first, the thoroughness and, secondly, the rapidity of the work to be done. The following may perhaps stand as a fair approximation to the truth :—

ESTIMATE OF ANNUAL COST OF STATE SURVEY.

Director	$5,000	
Chemist	3,000	
Two Palæontologists	3,000	
Assistant in Oil Region	2,000	
" " Bituminous Coal Region	2,000	
" " Iron Ore Region	2,000	
" at Pottsville	2,000	
" " Wilkesbarre	2,000	
" in Southeastern Pennsylvania	3,000	
		$24,000
Laboratory (for first year only)	2,000	
Chemist's Assistant	1,000	
Field party for Oil Region	3,000	
" " Bituminous Coal Region	3,000	
Rent of house for Museum	1,000	
Assistant in Museum	1,000	
Incidental expenses	500	
Traveling and Transport expenses	1,000	
Instruments and Vehicles (first year)	1,500	
		$14,000
Publishing Department :		
Draughtsman	3,000	
Lithographing and Wood-cutting, Printing, Binding and Distributing the Work of the Year, with Maps and Illustrations (say 1000 pages 8vo., 10 maps and 100 wood cuts) 5000 copies	6,000	
		9,000
Total		$47,000

By including the item of publishing in the estimate we should avoid delays at the close of the year, and make each year's work complete and finished up to date; giving the Legislature opportunity to pass judgment on the work, while the public are not kept out of the use of the results as fast as they are obtained.

I do not include the triangular and astronomical determination work in the estimate, because I believe I have Prof. Pierce's assurance that the Coast Survey will relieve the State from this burden to a considerable extent.

I can think of nothing more at present to suggest, and beg you to excuse the great length to which this subject has protracted my letter.

Your obedient servant,

J. P. Lesley.

P. S.—If the mineral wealth of Pennsylvania is to be properly exhibited at the Centennial Anniversary, a better method of accomplishing this result could not be devised, nor one so cheap, as by the organization of a State Geological Survey.